S-5/PHSH/DSE-I/22

TDP (Honours) 5th Semester Exam., 2022

PHYSICS

(Honours)

FIRST PAPER : DSE – I

Full Marks : 80 *Time* : 3 Hours

*Answer from **both** the Sections as directed.*

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

SECTION—A

1. Answer *any* **eight** of the following questions : 2×8=16

(a) Define angular momentum of the nucleus.

(b) Show that the density of nucleus is independent of mass number.

(c) What is wave mechanical parity?

(d) What is the significance of Q-value?

(e) Write Geiger-Nuttall law.

(f) Explain the term nuclear reaction cross-section.

(g) What is tunnel effect?

(h) Explain Bremsstrahlung.

(i) What is radiation length?

(j) What are Hadrons?

SECTION—B

There are *four* questions from Question No. 2 to Question No. 5. Answer either *(a)* **or** *(b)* from each question given below : 16×4=64

2. *(a)* *(i)* Explain about Nuclear stability w.r.t. neutron-proton ratio and also explain why stable nuclei have more neutrons than protons.

(ii) What is binding energy per nucleon? Discuss graphically the variation of average binding energy per nucleon with mass number and stability of the nucleus.

(iii) Calculate the packing fraction and average binding energy per nucleon for 80^{16} of nuclear mass 15·994916 u; given m_p = 1·007825 u, m_n=1·008665 u.

(iv) State the basic assumptions of liquid drop model and show how it can explain the nuclear fission.

(2+2)+(1+4)+3+4=16

(OR)

(b) (i) Write the basic differences between liquid drop model and shell model of the nucleus.

(ii) What is the evidence for the shell structure of the nuclei?

(iii) Stating the main assumptions, explain the nuclear shell model and its limitations.

(iv) Explain that nuclear forces are charge independent and nuclear forces are exchange forces.

2+3+(2+3+2)+(2+2)=16

3. (a) (i) Explain why high energy of α-particles favours their emission.

(ii) What is meant by range of an α-particles? On what factors does it depend? Explain straggling effect.

(iii) Explain neutrino hypothesis. Explain qualitatively how the hypothesis of a neutrion solves the apparent breakdown of conservation of momentum and energy in β-decay.

(iv) What do you mean by internal conversion? How is it different from photo-electric effect?

2+(1+2+2)+(2+4)+(1+2)=16

(OR)

(b) (i) Describe different types of nuclear reaction.

(ii) Write different types of conservation laws related to nuclear reactions.

(iii) Calculate the threshold energy required to initiate the reaction

$P^{31}(n, p)Si^{31}$; Given $m_p = 1{\cdot}00814$ u

$m_n = 1{\cdot}00898$ u

$M_P = 30{\cdot}98356$ u

$M_{Si} = 30{\cdot}98515$ unit.

(iv) Discuss Gamow's theory of emission of α-particle from a radioactive substance.

4+4+3+5=16

4. (a) (i) Derive the expression of Bethe-Bloch formula for energy loss due to ionization by a moving heavy charged particle in the surrounding medium.

(ii) Explain why the energy loss of electrons is much more complicated phenomenon compared to the energy loss by ionisation of heavy ions.

(iii) Discuss the working of scintillation Detector.

(iv) Write the uses of scintillation detector.

6+3+5+2=16

(OR)

(b) (i) Describe the construction and working theory of an ionisation chamber.

(ii) What are the advantages and disadvantages of using GM counter over Ionisation chamber.

(iii) A G. M counter produces $4{\cdot}5 \times 10^8$ ions per discharge. If it responds to an incident radiation 10 times per sec, what is the average ion current through the counter?

(iv) Describe the main process of interaction of γ - radiation with matter by which radiation loses energy on passage through matter.

6+4+2+4=16

5. (a) (i) Explain, what is meant by resonance condition in a cyclotron. Derive an expression for the maximum energy produced in this machine. What happens when the energy becomes relativistically high?

(ii) Write a short note on Hyperons.

(iii) Check if the following reactions are allowed or forbidden :

$\pi^- + P \rightarrow \wedge^0 + \pi^0$

and $P + \bar{P} \rightarrow 2\pi^+ + 2\pi^- + 2\pi^0$

(2+3+2)+3+(3+3)=16

(OR)

(b) (i) Describe the construction and working of an electron synchrotron.

(ii) What are strange particles? How are the strangeness quantum number, baryon number and the third component of isotopic spin related to the elementary particles?

(iii) What do you mean by 'quarks'? How many possible quarks are there? Give the charge and quantum number associated with each quark. How do the quarks combine to form proton and π^+ meson? 5+(1+3)+(1+1+3+2)=16

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